11-16-05 BEST AVAILABLE COPY AF 2624 IFW

BRYAN CAVE

OIPE IAP88 NOV 14 2005 PATENT & TRADEMARK OFFICE

Allan W. Watts
Registered Patent Attorney
Voice: 602-364-7331
ALLAN.WATTS@BRYANCAVE.COM

November 14, 2005

VIA U.S. EXPRESS MAIL

Bryan Cave LLP
One Renaissance Square
Two North Central Avenue
Suite 2200
Phoenix, AZ 85004-4406
Tel (602) 364-7000
Fax (602) 364-7070
www.bryancave.com

Chicago
Hong Kong
Irvine
Jefferson City
Kansas City
Kuwait
Los Angeles
New York
Phoenix
Riyadh
Shanghai
St. Louis
United Arab Emirates (Dubai)
Washington, DC

And Bryan Cave, A Multinational Partnership,
London

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Re: U.S. Application Serial No. 09/691,413
Inventor: Sang-Hee Lee, et al.
Title: Video Predictive Coding Apparatus and Method
Filing Date: October 18, 2000
Attorney Docket No.: 0118297

Dear Sir/Madam:

Enclosed herewith for filing in the above-identified application are the following:

1. Transmittal Letter (2 pgs.);
2. Appellants' Amended Brief on Appeal + Appendix (55 pgs.);
3. Exhibit 1 (16 pgs.);
4. Exhibit 2 (2 pgs.);
5. Exhibit 3 (13 pgs.); and
6. Self-addressed, prepaid postcard to acknowledge receipt of documents.

We hereby authorize the Commissioner to charge any fees to Deposit Account No. 02-4467.

Very truly yours,

Allan W. Watts

Allan W. Watts

Enclosures

518284.2/0118297

OIPE IAP88
NOV 14 2005
PATENT & TRADEMARK OFFICE

CERTIFICATE OF EXPRESS MAILING UNDER 37 C.F.R. 1.10.

I hereby certify that this document (and any others referred to as being attached or enclosed) is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" service, mailing label No. **EV497393666US** on **November 14, 2005** and addressed to Mail Stop Appeal Brief – Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Melinda M. Erway

Printed Name: Melinda M. Erway

EV497393666US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)
	)
Sang-Hee LEE, et al.	) Examiner: Wenpeng Chen
	)
Serial No.: 09/691,413	) Group Art Unit: 2624
	)
Filed: October 18, 2000	

For: **VIDEO PREDICTIVE CODING APPARATUS AND METHOD**

Phoenix, Arizona
November 14, 2005

APPELLANTS' AMENDED BRIEF ON APPEAL

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an appeal from the final rejection of all claims which are pending in this application, specifically, claims 1, 30, 31, 37-39, 44-52 and 54-61. This brief has been amended in response to the Office Communication mailed October 12, 2005, without consenting to the statements made in the Office Communication, but responsive thereto. The fee for this appeal is believed to have been paid previously. However, if the fee was not paid or is deficient, or if any other fees are due upon filing of this Amended Brief on Appeal, please charge such fees (or credit any overpayment) to Deposit Account No. 02-4467.

The Notice of Appeal was filed on June 6, 2005 by Express Mail. Appellants' Brief on Appeal was timely filed on August 5, 2005. An Office Communication inviting changes to the Appeal Brief was mailed on October 12, 2005, providing one month for response. Since November 12, 2005 is a Saturday, this Amended Brief on Appeal is timely filed upon mailing with a certificate of mailing on or before Monday, November 14, 2005.

(i) IDENTIFICATION OF REAL PARTY IN INTEREST

The real party in interest is Hyundai Curitel Communication, Inc., which is the assignee of record of the present application and is a publicly traded company organized and existing under the laws of the Republic of Korea.

(ii) RELATED APPEALS AND INTERFERENCES

Upon information and belief of undersigned counsel, appellants and the assignee of record are not aware that there are any pending appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

(iii) STATUS OF CLAIMS

Claims 1, 30, 31, 37-39, 44-52 and 54-61 have been rejected and are being appealed.

Claims 2-29, 32-36, 40-43, and 53 have previously been cancelled.

No claims have been allowed in this application. But claims 3-29 were allowed to issue in the original US application, Serial No. 08/940,937, which became US Patent No. 6,215,905. This application on appeal is a continuation of that original application.

Claim 38 has also been objected to due to a typographical error. The reason for this objection is described in greater detail in the next section of this document.

(iv) STATUS OF AMENDMENTS

Applicants filed an amendment on July 12, 2005, pursuant to 37 C.F.R. §1.116 to place the subject matter of claim 38 in better form. Specifically, in the final Office Action mailed February 4, 2005, paragraph 5, the Patent Office objected to claim 38 and directed that the term "the left left upper block" be changed to "the left upper block". Applicants have requested that claim 38 be amended accordingly to correct this obvious typographical error. However, in an Advisory Action mailed on 07/26/2005, the Patent Office indicated that the amendment would not be entered because it was not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal.

No other amendments have been filed subsequent to final rejection.

(v) SUMMARY OF CLAIMED SUBJECT MATTER

Claims 1, 37, 44, 48, 54, and 58 are independent claims. These independent claims and the dependent claims on appeal are focused on a particular area of video coding that involves predicting DC coefficients or DC values of blocks of video code using DC coefficients or DC values from neighboring blocks. All of the pending claims include blocks and DC values or DC coefficients, or similar language. Specifically, all of the independent claims indicate in their preambles that they are block based video coding methods[1] or apparatuses[2]. The independent claims[3] contain a "left upper block

[1] Independent claims 1, 44, and 54 are method claims.

[2] Independent claims 37, 48, and 58 are apparatus claims.

(B1)", an "upper block (B2)", a "left block (B3)", a "target block (B), or a combination thereof, which are shown, for example, in FIGS. 6-10, and are described with reference thereto in the specification, for example, at page 17, line 7 to page 25, line 11.

Certain DC values are found in independent claims 1, 37, 44, and 48, and DC coefficients are found in independent claims 54 and 58. Claim 58 also includes AC coefficients. DC values are described in the specification on page 15, lines 6 – 8. And DC coefficients are described in the specification on page 17, line 8 *et seq.* The relationship between DC coefficients and AC coefficients (and DC values and AC values) is shown in FIG. 1.

To explain how certain elements relate to each other, DC coefficients are obtained by performing a discrete cosine transform (DCT) to change a block of pixel values into a transform domain representation.[4] Such DC coefficients may be quantized into a DC value according to a rate control policy.[5] A DC value represents a characteristic of the signal of the block.[6] The embodiment of the invention claimed in claim 1, for example, may be explained with reference to figure 6. In this example, the DC value of block B is to be predicted or coded, using blocks B1, B2, and B3.[7]

In the embodiment of claim 1, the DC values of blocks B1, B2, and B3 may be known. The difference between the DC value of block B1 and the DC value of block B2 is calculated, and the difference between the DC value of block B1 and the DC value of block B2 is calculated.[8] These two differences may then be compared, and the DC value of block B2 or B3 may be selected based on this comparison.[9] For instance, the DC value of block B may be predicted to be the same as the DC value selected from blocks B2 and B3.[10]

Independent claim 37 is similar in many respects to claim 1, but contains a "selection means" and a "prediction means", which may include, for instance, "predictive block selector 62" shown, for example, in FIGS. 14 and 15, and described, for instance,

---

[3] Independent claims 1, 37, 54, and 58 refer to these blocks by the directions and reference numbers, while independent claims 44 and 48 refer to first, second, and third blocks and a target block.

[4] Specification, pages 1(first line) -3 (last line).

[5] Specification, page 14, line 10 et seq.

[6] Specification, page 15, lines 6-8.

[7] Specification, page 17.

[8] Claim 1; Specification, for example, page 19.

[9] Claim 1, Specification, for example, page 20.

[10] Claim 1; Specification, for example, page 20.

on page 12, lines 10 to page 13 line 14. Independent claim 44 contains many of the elements already described, but also contains "differential values", a "differential pulse code modulated coder" and "performing differential pulse code modulated coding", each in combination with other limitations. FIG. 12 is a flow chart that illustrates differential pulse code modulation, "DPCM", as well as other steps relevant to a number of the claims. Further, FIGS. 14 and 15 include "DPCM coder" 63, which is described on page 12, line 10 *et seq.*, for example.

Independent claim 48 also contains the differential pulse code modulation just described, and also "selector circuitry" which may include, for instance, "predictive block selector 62" shown, for example, in FIGS. 14 and 15, and described, for instance, on page 12, lines 10 to page 13 line 14. Independent claim 54 includes vertical and horizontal gradients, which are described, for example, in the specification at page 1, line 5, on page 13 et seq., and in FIG. 12. Further, independent claim 58 includes texture data, which is described, for instance, in the specification at page 1, the last two lines.

(vi) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

The issue on appeal is whether all claims (claims 1, 30, 31, 37-39, 44-52 and 54-61) are unpatentable under 35 U.S.C. §103 over Kuriacose et al., U.S. Patent 5,111,292 in view of Graham, U.S. Patent 2,905,756.

Specifically, in the final action mailed 02/04/2005, the Patent Office rejected claims 1, 30-31, 37-39, 44-52 and 54-61 (all of the pending claims) under 35 U.S.C. §103(a) as being unpatentable over Kuriacose in view of Graham.[11] The Patent Office stated that "generating a predictive DC value of the a [sic] DC value of the target block" was taught in Kuriacose at col. 6, lines 33-46.[12] But the Patent Office admitted that "Kuriacose does not teach the features related to generating a predictive DC value with a selected DC value" as recited in the claims.[13] The Patent Office cited Graham,[14] and wrote that it would have been obvious to substitute the DC values of the blocks of Kuriacose for the pixels of Graham because it would be desirable to have better compression of an image array.[15] The Patent Office applied this rejection to all of the pending claims.[16] However, the Patent Office admitted that Kuriacose does not teach "generating a predictive DC value with a selected DC value" as recited in the claims.[17]

---

[11] U.S. Patents 5,111,292 and 2,905,756; final action page 6.

[12] Final action page 6.

[13] Final action page 7.

[14] Citing Fig. 3 and Col. 6, lines 27-47.

[15] Final action, pages 7 and 8.

[16] Final action, pages 8-10.

[17] Final action, page 10.

Rather, the Patent Office once again cited Graham[18] and argued that delays 45, 46, and 44 are storage positions that temporarily store DC coefficients,[19] and that it was desirable to have better compression of an image value array.[20]

In a telephone interview conducted on July 21, 2005, Applicants' counsel presented arguments similar to those presented herein, and Examiner Chen responded that he did not find the arguments to be persuasive.[21]

(vii) ARGUMENT

SUMMARY OF ARGUMENT

Applicants respectfully submit that a *prima facie* case of obviousness has not been established, or in the alternative, is rebutted. Applicants submit that the present invention is focused on a particular area of video coding that involves predicting DC coefficients or DC values of blocks of video code using DC coefficients or values from neighboring blocks. The present invention represents a significant specific improvement in a rapidly advancing area of technology. The reference Graham, which was filed in 1956, is from a time when video coding was in its infancy. At the time that Graham was filed, predictions were performed on single pixels, using values of other pixels. Neither discrete cosine transforms (DCT) nor manipulation of blocks of data were known in video coding at that time. Consequently, the steps of selecting DC values and predicting DC values as recited in claim 1 of the present application, for example, were meaningless in the context of the era of Graham. In fact, Graham predates the existence of the problem addressed by the present invention, namely, predictively coding DC coefficients of blocks of video code.

Consequently, if the present invention and the cited references are each considered as a whole, there would have been no motivation at the time the invention was made to look back in time to before the use of DCT on blocks of data to find a solution to the problem of improving the accuracy of predicting DC coefficients. Consequently, there was no motivation to combine Graham with Kuriacose (or to combine Graham with any other contemporary reference for that matter) to arrive at the present invention. Further, it would not be reasonable to expect a person of ordinary skill in the art to look to Graham for a solution to the specific problem addressed in the present invention. Such a person would have had no expectation of success

---

[18] Citing col. 5, lines 32-74.

[19] Final action, page 10.

[20] Final action, page 11.

[21] Advisory Action mailed 07/26/2005; Interview Summary signed 7/21/05.

associated with looking to Graham for a solution to the problem addressed by the present invention.

In addition, Graham functions fundamentally differently than the present invention since Graham predicts values for individual pixels rather than predicting DC values of blocks of pixels in a transform domain. As a result, Graham would not have commended itself to an inventors attention in considering the problem addressed by the present invention. Further, since Graham teaches predicting individual pixels, Graham effectively teaches away from the approach of the present invention of handling data in blocks, performing DCT manipulations, and predicting DC values or coefficients of the blocks. Moreover, since it does not anticipate the problem addressed by the current invention, Graham does nothing to suggest the desirability of predicting DC coefficients or DC values of blocks. Further still, if Graham were modified to arrive at the present invention, such a modification would change the principle of operation of Graham, since instead of predicting individual pixels, DC coefficients or values of blocks would be predicted after performing DCT operations.

Furthermore, Kuriacose contains no suggestion for being combined with Graham to arrive at the present invention. A person of ordinary skill in the art, having studied Kuriacose, and perhaps familiar with other work in the use of DCT to compress video code, would have no motivation to look to a reference written in 1956 to solve the problem of predicting DC coefficients or values of blocks of data, and would have no reasonable expectation that such an inquiry would be successful. There is no motivation within Kuriacose itself to combine it with Graham, and nor would there have been motivation in the knowledge of people skilled in the art to look to a reference such as Graham for a solution to the problem of how to more efficiently predict DC coefficients or DC values of block of video code. Further, separate from combining with Graham, Kuriacose makes no other suggestion of the desirability of the claimed invention, as recited in claim 1, for example. Thus, there is no motivation within Kuriacose or elsewhere in the prior art to combine it with any other reference to arrive at the claimed invention.

Consequently, under the circumstances of the current application, from the vantage point of a person of ordinary skill in the art, Graham was outside the scope of the endeavor of the present invention. It is only by improperly applying hindsight from Applicants' disclosure that a piecemeal combination of Graham and Kuriacose might seem apparent. Applicants submit that the cited references of Graham and Kuriacose do not obviate the present invention, as currently claimed, and request that the final rejection of the current claims be overruled and that a patent be allowed to issue.

THE LEGAL STANDARD

To reject claims in an application under 35 U.S.C. 103, an Examiner must show an unrebutted *prima facie* case of obviousness. *See In re Deuel*, 34 USPQ2d 1210, 1214 (Fed. Cir. 1995). In the absence of a proper *prima facie* case of obviousness, an

applicant who complies with the other statutory requirements is entitled to a patent. *See In re Oetiker*, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992). A conclusion of obviousness is evaluated not only with regard to whether the Examiner has met the burden of establishing a *prima facie* case of obviousness based upon the prior art, but also in the context of whether rebuttal evidence has been evaluated fully and fairly. *In re Piasecki*, 223 USPQ 785, 787-788 (Fed. Cir. 1984). On appeal to the Board, an applicant can overcome a rejection by showing insufficient evidence of *prima facie* obviousness or by rebutting a *prima facie* case with evidence of secondary *indicia* of nonobviousness. *See Oetiker*, 24 USPQ2d at 1444.

Applicants respectfully submit that a *prima facie* case of obviousness has not been established, or if it has been established, that evidence has been presented that if properly considered would rebut the case of obviousness.

POINT I

THE PRESENT INVENTION IS A SIGNIFICANT IMPROVEMENT IN AN AREA OF TECHNOLOGY THAT IS LIMITED TO APPLICATIONS USING DISCRETE COSINE TRANSFORMS AND DC COEFFICIENTS OR DC VALUES, AND IF THE INVENTION WAS OBVIOUS, SOMEONE ELSE WOULD HAVE INVENTED IT

Although only in use since about 1930, and only in widespread use since about the 1950s, television has had a very important impact on human society. The number of people who watch television, and the time that they spend doing it is staggering. Television has become a medium for spreading information and ideas, through news broadcasts for example, and has been credited with impacting many world events, including teaching common languages, raising awareness of other cultures, and changing expectations regarding liberty and opportunities for prosperity, which has arguably contributed to changes ranging from social advances to the changing of governments. In recent years, other video media have come into more widespread use, including, for example, Internet transmission of video media, which facilitates dissemination of a wider variety of information from many more sources often custom tailored for narrow audiences. The long term impact on society of video media can only be imagined, but it is clear that the impact will be substantial.

In addition to other societal impacts, video media has a tremendous economic value. However, video code occupies significant storage space when being stored, and takes up significant bandwidth when being transmitted.[22] Consequently, there is tremendous motivation to improve the efficiency with which video code is stored and transmitted. As a result, a large quantity of work has been done to develop systems

[22] Graham, col. 1, lines 18-20.

and methods to compress video data.[23] Graham illustrates some early work in this area in which individual pixels were predicted by evaluating neighboring pixels.[24] Many years after Graham, it was learned that video data could be compressed by performing a discrete cosine transform (DCT) on blocks of pixels, which evolved into its own area of technology, including a number of endeavors.[25] Kuriacose illustrates that DCT was known prior to the present invention.[26] As illustrated in FIG. 1 of the present patent application, the DCT results in one DC and multiple AC coefficients for each block of pixels.[27] It is well settled that the scope of an invention in a patent or patent application is determined by the claims, and each of the currently pending claims includes at least one of DC values and DC coefficients.[28] DC values, found in some claims, are quantized from DC coefficients.[29] Further, as stated in the Field of the Invention section of the specification[30],

> [t]he present invention relates to predictive coding for a video encoding system, and more particularly, to a video predictive coding apparatus and method thereof, which can enhance the coding efficiency by predictively coding <u>DC coefficients</u> of a <u>block</u> to be coded using <u>DC gradients</u> of a plurality of previously coded neighboring <u>blocks</u>.

(Emphasis added.) Thus, the field of the endeavor of the present invention is limited to video coding applications that include such DC values or DC coefficients, and implicitly, to applications that employ DCT manipulation of blocks of pixel values.[31] In fact, the field of the endeavor of the claimed invention is limited to systems and methods

---

[23] Exhibit 2 illustrates that much work has been done just in the area of DCT and just since DCT has been used.

[24] Col. 5, lines 6-31.

[25] A search on the US Patent and Trademark Office website (USPTO.gov) of issued US Patents for the words (video and DCT and "DC coefficient") produced 580 hits (Exhibit 2), the earliest of which was US Patent 4,930,020 (Exhibit 3), which was filed in 1989 and claimed priority to a foreign application filed on May 9, 1988. The background section of De With indicates that the benefits of DCT were known at that time (col. 1, lines 51-53), citing a 1984 IEEE article.

[26] Kuriacose, col. 3, lines 59-60; Kuriacose was the fourth earliest of the 580 US patents identified in the search mentioned in the previous footnote and attached as Exhibit 2.

[27] *See also*, specification, page 14 *et seq.*

[28] *See* Pending Claims, APPENDIX.

[29] Specification, page 14.

[30] Page 1, lines 1 – 6.

[31] Claims; specification, page 14.

for selecting or predicting DC coefficients or DC values in video coding applications employing DCT manipulation of blocks of pixel values.[32]

As described in the ISO/IEC paper JTC1/SC29/WG11 (the ISO/IEC paper) provided in Exhibit 1, the performance of video coding in accordance with the present invention has been compared to other alternatives available at that time.[33] It was found that the DC prediction method of the present invention provided the best prediction performance, in terms of bit savings, of the methods that were tested.[34] In addition, in comparison with the alternatives, the method of the present invention provided the improvement in efficiency with only a negligible increase in complexity.[35] Further, syntax changes were not required to implement the improvement, and the changes could be applied on a block basis.[36]

Thus, the present invention represents a significant improvement over the prior art in a socially and economically important area of technology. This illustrates why Applicants are still pursuing a patent on this invention almost nine years after the original patent application was filed. Although significant because of the widespread transmission and storage of video code, this improvement is limited to a particular area of technology, namely, video coding applications that include DC values or DC coefficients, and implicitly, to applications that employ DCT manipulation of blocks of pixel values.[37] This area of technology is shared by many other patents, which indicates the high potential value, even, *arguendo*, for small improvements in this area.[38]

In addition, Applicants submit that even if, *arguendo*, the present invention had been obvious at the time it was made, others would have discovered it, which did not occur. As mentioned, the present invention is in an area of technology that has been advancing rapidly.[39] Furthermore, DCT had been used in video coding since the 1980's, possibly since before 1984.[40] Thus, *arguendo*, had the invention been obvious,

---

[32] Independent Claims.

[33] Exhibit 1, page 1.

[34] Page 8.

[35] Page 4.

[36] *Id.*

[37] Claims.

[38] *See* Exhibits 2. A total of 580 hits were identified, dating back only to about 1989.

[39] *See* Exhibit 2. 580 hits were identified in the search, the first issuing in 1990 and filed in the U.S. in 1989.

[40] Exhibit 3. The background section of De With, first filed in the Netherlands in 1988, indicates that the benefits of DCT were known at that time (col. 1, lines 51-53), citing a 1984 IEEE article.

there would have been plenty of time for one of the many other people working in that area to come up with it, which they did not.

POINT II

GRAHAM IS NOT REASONABLY PERTINENT TO THE PARTICULAR PROBLEM ADDRESSED BY THE PRESENT INVENTION

Graham, U.S. Patent 2,905,756, teaches a method and apparatus for reducing television bandwidth.[41] Instead of transmitting information for each pixel for each frame of a television picture, Graham teaches prediction of the future of the signal in terms of the past.[42] Rather than transmitting information for each pixel, a smaller error signal is transmitted that represents the difference between the actual and predicted signal.[43] This reduces the total amount of information that must be transmitted, thus reducing the required bandwidth.[44]

Graham goes a step further and teaches using a number of different prediction schemes dependent on the nature of the local picture environment.[45] One method described involves determining the direction of constant brightness contour lines in the vicinity of the pixel to be predicted and making a prediction parallel to the contour lines.[46] Specifically, the method described assumes that contour lines are either horizontal or vertical, and selects one or the other by calculating the difference between the brightness of the pixel above (S_{01}) and the brightness of the pixel to the left of that (S_{11}), and the difference between the brightness of the pixel to the left (S_{10}) and the brightness of the pixel above that (S_{11}).[47] These differences are then compared and either the brightness of the pixel above (S_{01}) or the brightness of the pixel to the left (S_{10}) is selected as a prediction for the pixel to be predicted (S_{00}).[48] But these are pixels, not blocks, and the values being calculated are brightnesses, not DC coefficients or DC values.

---

[41] Title.

[42] Col. 1, lines 34-37.

[43] Col.. 1, lines 39-43.

[44] Col.. 1, lines 42-44.

[45] Col. 2, lines 10-31.

[46] Col. 2, lines 43-49.

[47] Col. 5, lines 6-31.

[48] *Id.*

In the context of an obviousness analysis under 35 U.S.C. § 103, both the claimed invention[49] and the cited references[50] must be considered as a whole. The correct question is not whether the differences between the present invention and the prior art would have been obvious, but rather, whether the claimed invention as a whole would have been obvious from the prior art.[51] Since the present invention is directed toward predictively coding DC values or coefficients of blocks,[52] it must be taken in that context. Similarly, since Graham predates DC coefficients and the performing of discrete cosine transforms (DCT) on blocks of data, and has nothing to do with such operations, Graham must be taken as a whole in that context. When taken as a whole, Graham has nothing to do with the specific problem addressed by the present invention, namely, improving the accuracy or efficiency with which DC values or DC coefficients are predicted for blocks of pixel values upon which DCT manipulations have been performed.

Further, to rely on a reference in a rejection under 35 U.S.C. § 103, the reference must be reasonably pertinent to the particular problem with which the inventor was concerned.[53] In addition, a reference must have logically commended itself to the inventors attention in considering his problem.[54] Furthermore, the circumstances of the application, from the vantage point of a person of ordinary skill in the art, must be considered in assessing the scope of the endeavor.[55] The present invention is concerned with improving the accuracy or efficiency with which DC values or DC coefficients are predicted for blocks of pixel values upon which DCT manipulations have been performed.[56] However, Graham not only fails to disclose DC values, DC coefficients, DCT manipulations, or manipulation of blocks of pixels, but also is from a time when such things were not even found in the field of the invention.[57] Consequently, Graham is outside of the field of the endeavor of the present invention, is not reasonably pertinent to the problem with which the present invention is concerned, and would not have logically commended itself to the inventors attention in considering

---

[49] *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); *Schenck v. Nrotron Corp.*, 713 F.2d 782, 218 USPQ 698 (Fed. Cir. 1983).

[50] *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983) *cert. denied* 469 U.S. 851 (1984).

[51] *Stratoflex*, at 1530, 871; *Schenck* at 782, 698.

[52] Claims, Field of the Invention.

[53] *In re Oetiker,* 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992); *In re Deminski,* 796 F.2d 436, 230 USPQ 313 (Fed. Cir. 1986).

[54] *In re Clay,* 966 F.2d 656, 659, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992).

[55] *In re Bigio* 9, (Fed. Cir., August 24, 2004).

[56] *See* the claims on appeal.

[57] *See* Exhibits 2 and 3. A total of 580 hits were identified, dating back only to an application filed in the U.S. in 1989. Graham was filed in 1956.

the problem addressed by the present invention. At the time the present invention was made, there was no motivation for a person of ordinary skill in the art to look back in time to before the use of DCT on blocks of data to find a solution for the problem of improving the efficiency of predicting DC coefficients or DC values.

Further, a factor that may be considered in determining the level of ordinary skill in the art is the rapidity with which innovations are made in that particular field.[58] The field of video coding, and particularly, using DCT in video compression, is an art in which innovations have been made very rapidly in recent years.[59] Consequently it would not have been reasonable to expect a person of ordinary skill in the art to have looked to a 40-year-old reference for a solution to a problem in an area of technology that might have existed for only about 12 years time.[60] Therefore, it would not be reasonable to have expected an inventor, at the time the present invention was made, to look to a reference such as Graham for a solution to the problem of improving the accuracy or efficiency with which DC values or DC coefficients are predicted for blocks of pixel values upon which DCT manipulations have been performed. A person of ordinary skill in the art would have had no reasonable expectation of success associated with looking to Graham for a solution to the problem addressed by the current invention.

Even if, *arguendo*, the benefits of improving the efficiency of video compression were obvious at the time of the invention, and even if, *arguendo*, it was obvious that improving the prediction of DC coefficients or DC values would improve the efficiency of video compression, that still does not suggest that it would be obvious to substitute DC coefficients or values into the mathematical operations performed in Graham on pixel values, since there was no suggestion or motivation to turn to Graham for this purpose.

POINT III

THERE IS NO MOTIVATION WITHIN GRAHAM TO COMBINE IT WITH ANOTHER REFERENCE TO ARRIVE AT THE PRESENT INVENTION AND SUCH A MODIFICATION OF GRAHAM WOULD CHANGE ITS PRINCIPLE OF OPERATION

---

[58] *Environmental Designs Ltd. V. Union Oil Co.,* 713 F.2d 693,696, 218 USPQ 865, 868 (Fed. Cir. 1983), *cert. denied*, 464 U.S. 1043 (1984).

[59] A search on the US Patent and Trademark Office website (USPTO.gov) of issued US Patents for the words (video and DCT and "DC coefficient") produced 580 hits dating back only to about 1989. See Exhibits 2 and 3.

[60] The patent in Exhibit 2 that was the first to issue was US Patent 4,930,020, (Exhibit 3) which was filed in 1989 and claimed priority to a foreign application filed on May 9, 1988. This patent referenced a 1984 IEEE article published 12 years before the present invention was first filed in 1996.

For a rejection under 35 U.S.C. § 103 to stand, the prior art must contain a suggestion or motivation to combine the references.[61] The mere fact that references can be combined or modified does not render the resulting combination obvious unless the prior art also suggests the desirability of the combination.[62] Possible sources of a suggestion to combine include the prior art references cited against the claims, one of which is Graham in this case. However, since Graham does not contemplate DCT performed on blocks of pixels, DC coefficients, or DC values, Graham does not anticipate the problem addressed by the present invention and does nothing to suggest the desirability of predicting DC coefficients or DC values of blocks. There is no motivation within Graham to combine it with another reference to arrive at the present invention.

In addition, a proposed modification to a prior art reference cannot change the principle of operation of the reference.[63] If Graham were modified to arrive at the present invention, such a modification would change the principle of operation of Graham, since instead of predicting individual pixels, DC values of blocks would be predicted after performing DCT operations. Consequently, there is no motivation to combine Graham with Kuriacose (or to combine Graham with any other reference, for that matter) to arrive at the present invention. Furthermore, for a finding of obviousness, there must be a reasonable expectation of success.[64] Since Graham does nothing to suggest performing PCT on blocks of pixels or generating or predicting DC coefficients or DC values, and Graham comes from a time when such operations were not yet contemplated for video coding, if Graham is considered as a whole, there would be no expectation of success associated with modifying Graham to arrive at the present invention. Moreover, since Graham teaches predicting individual pixels, if considered in its entirety, Graham effectively teaches away from the approach of the present invention of handling data in blocks, performing DCT manipulations, and predicting DC coefficients or DC values of the blocks.

Thus, there is no motivation or suggestion to combine Graham with other references or to arrive at the present invention, and a person of ordinary skill in the art contemplating such a combination would have no reasonable expectation of success. In fact, Graham teaches against the combination, and teaches against an expectation of success.

---

[61] *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

[62] *In re Mills,* 916F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990).

[63] *In re Ratti,* 270 F.2d 810, 123 USPQ 349 (CCPA 1959).

[64] *In re Merck & Co., Inc.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986); *Ex parte Blanc,* 13 USPQ2d 1383 (Bd. Pat. App. & Inter.. 1989).

POINT IV

THERE IS NO MOTIVATION WITHIN KURIACOSE TO COMBINE IT WITH GRAHAM OR ANOTHER REFERENCE FROM THAT TIME

Kuriacose, U.S. Patent 5,111,292, teaches an apparatus for encoding and decoding a high-density television (HDTV) signal that divides the signal into high and low priority channels.[65] The high priority channel contains the information that is most important to create the desired image,[66] and is transmitted with more power than the low priority channel.[67] Kuriacose teaches compressing video data,[68] blocks of pixels,[69] discrete cosine transforms (DCT),[70] DC coefficients,[71] and predicting frames.[72]

A person of skill in the art at the time of the invention, who sought to improve the prediction of DC coefficients or DC values, may have looked at Kuriacose for an attempted solution to that problem, since Kuriacose mentions DC coefficients[73] and performing DCT on blocks of pixels[74]. However, Kuriacose does not teach or suggest applicant's solution, and does not teach or suggest all of the limitations of any of the pending claims. Moreover, Kuriacose contains no motivation to look to Graham or any other prior art for the missing elements.

Specifically, Kuriacose illustrates that the concept of performing a DCT operation on blocks of video data predated the present invention, and was known in the art at the time the present invention was made. However, Kuriacose does not teach or suggest:

> Selecting a DC value of one of a left block (B3) and a upper block (B2) based on a comparison of a first value and a second value, the first value being a difference between DC values of a left upper block (B1) and the left block (B3), the second value being a difference between DC values of the left upper block (B1) and the upper block (B2)

or

---

[65] Abstract.

[66] Abstract; Col. 4, lines31-44.

[67] Col. 3, lines 3-5.

[68] Col. 1, lines 28-30; col. 2, lines 61-62.

[69] Col. 3, lines 56-60.

[70] Id.

[71] Col. 4, lines 4 and 42.

[72] Col. 3, lines 33-35.

[73] Col. 4, line 4.

[74] Col. 3, lines 59-63.

predicting the selected DC value as a DC value of a target block (B), thereby generating a predictive DC value of the target block

as recited in claim 1, for example.

Although Kuriacose discloses blocks, DCT, and DC coefficients, Kuriacose contains no suggestion of being combined with Graham to arrive at the present invention. A person of ordinary skill in the art, having studied Kuriacose, and perhaps familiar with other recent developments in use of DCT in video coding,[75] would have no motivation to look to a reference written in 1956 to solve the problem of predicting DC coefficients of blocks of data, and would have no reasonable expectation that such an inquiry would be successful.[76] There is no motivation within Kuriacose itself to combine it with Graham, and nor would there have been motivation to look to a reference such as Graham for a solution to the problem of how to more efficiently predict DC coefficients or DC values of blocks of video code. Further, Kuriacose makes no other suggestion of the desirability of the claimed invention, as recited in claim 1, for example. Thus, there is no motivation within Kuriacose to combine it with any other reference to arrive at the claimed invention.

POINT V

THERE IS NO OTHER SUGGESTION OR MOTIVATION TO COMBINE REFERENCES OR ARRIVE AT THE PRESENT INVENTION

Motivation to combine references in an obviousness rejection must come from the nature of the problem to be solved, the teachings of the prior art, or the knowledge of persons of ordinary skill in the art.[77] The previous points in this document show that the cited references do not provide motivation to combine the references. This section addresses whether there is any other source of motivation to combine the references. Prior cases have established that just a statement that the modifications of the prior art to meet the claimed invention would have been within the ordinary skill in the art is not enough to establish obviousness.[78]

---

[75] For instance, the portion of the 580 patents listed in Exhibit 2 that had issued at that time.

[76] *See* Exhibit 2. The first U.S. patent application to be filed in this area of technology was filed in 1989.

[77] *In re Rouffet,* 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998); *Al-Site Corp. v. VSI Int'l Inc.,* 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999).

[78] *Ex parte Levengood,* 28 USPQ2d 1300 (Bd. Pat. App. & Inter.. 1993); *In re Kotzab*, 217 F.3d 1365, 1371, 55 USPQ2d 1313, 1318 (Fed. Cir. 2000); *Al-Site Corp. v. VSI Int'l Inc.,* 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999).

Since the problem addressed by the present invention is to better predict DC coefficients or DC values, the nature of the problem does not suggest looking to Graham or any reference from a time long before the problem came into existence to find a solution.[79] In addition, the knowledge of persons of skill in the art would not have suggested such a course of action.[80] Even if it was obvious that a better prediction of DC coefficients or DC values would result in better compression, and even if it was obvious that better compression would be beneficial, Graham was outside of the field of the endeavor of the present invention, and no motivation has been presented to look to Graham, or any other reference from that time period, for a solution to the problem of how to better predict DC coefficients or DC values.

Neither has any other evidence been presented that the knowledge of a person of ordinary skill in the art would have suggested looking to Graham, combining Kuriacose with Graham, or modifying either Graham or Kuriacose to arrive at the present invention. Motivation to improve video coding efficiency *per se* or even to better predict DC coefficients or DC values *per se* does not translate into motivation to combine the cited references or motivation to solve the problem in the particular manner claimed in the present invention. Rather, it is only through hindsight from Applicants disclosure that similarities between the steps taken in Graham and the steps taken in the present invention might be apparent.

CONCLUSION

Video is an important area of technology and more efficient coding allows more video to be transmitted and stored for a given band width and storage capacity. Quite a bit of work has been done to improve the efficiency with which video is coded, and the present invention represents at least one improvement, specifically in the area of selecting or predicting DC coefficients or DC values of blocks of pixel values. The first U.S. patent that was found to have issued in this specific area was not filed in the U.S. until 1989, but a lot of work has been done in this area since then. Kuriacose teaches performing discrete cosine transforms (DCT) on blocks of pixel values and DC coefficients, but does not teach or suggest the claimed steps for predicting DC values or DC coefficients. Graham teaches certain operations that are performed on pixel values to predict other pixel values, but this is different than performing such operations on DC values or DC coefficients. Further, Graham is from a time when video coding was in its infancy, and long predates the use of DCT, DC coefficients, and DC values in video coding. Consequently, Graham is not from the same field of endeavor as the present invention and Graham is not, and cannot be, reasonably pertinent to the particular problem addressed by the present invention. Graham would not have logically

---

[79] Exhibit 3 illustrates that DCT and DC coefficients were not known in video prior to about 1984 or 1989.

[80] Id.

commended itself to the inventors attention in considering how to better predict DC coefficients or DC values, and an inventor would have had no reasonable expectation that such an inquiry would lead to success. At the time the invention was made, a person of ordinary skill in the art would have had no motivation too look back in time to before the use of DCT on blocks of data to find Applicants' solution to the problem of improving the efficiency of predicting DC coefficients or DC values.

Since Graham predates the problem addressed by the present invention, and predates performing DCT on blocks of data in video coding, Graham does nothing to suggest its combination with later work involving DCT in video coding. In addition, if Graham were modified to arrive at the present invention, such a modification would change the principle of operation of Graham, since instead of predicting individual pixel values, DC values or DC coefficients would be predicted after performing DCT operations. Consequently, Graham provides no motivation to combine and no reasonable expectation of success. Furthermore, since DCT was only used in video coding recently, there would have been no motivation to combine with Graham in the nature of the problem to be solved or in the knowledge of those in the field of video coding at that time who were familiar with recent use of DCT in video coding. Moreover, although Kuriacose mentions DCT and DC coefficients, it contains no motivation to look to Graham specifically, or to any reference from the time of Graham, to find a solution to the problem of how to predict DC coefficients or DC values more efficiently. Further, since others have worked so hard in this area of technology, and the present invention is such an important advancement, if, *arguendo*, the present invention had been obvious, someone else would have invented it prior to the Applicants.

Consequently, Applicants submit that the present invention would not have been obvious without improperly applied hindsight. Applicants respectfully submit that either no prima facie case of obviousness has been established or in the alternative, that obviousness under 35 U.S.C. § 103 has been rebutted. Applicants request that the final rejection of the current claims be overruled and that a patent be allowed to issue containing the current claims.

Respectfully Submitted,

By: Allan W. Watts

Allan W. Watts

Reg. No. 45,930

(viii) CLAIMS APPENDIX

Pending Claims

1. A block based video coding method comprising the steps of:

   a) selecting a DC value of one of a left block (B3) and a upper block (B2) based on a comparison of a first value and a second value, the first value being a difference between DC values of a left upper block (B1) and the left block (B3), the second value being a difference between DC values of the left upper block (B1) and the upper block (B2); and

   b) predicting the selected DC value as a DC value of a target block (B), thereby generating a predictive DC value of the target block.

30. The method as recited in claim 1, wherein said step a) includes the steps of:

   a1) obtaining a first differential value which is a difference between DC values of the left upper block (DC_B1) and the upper block (DC_B2);

   a2) obtaining a second differential value which is a difference between DC values of the left upper block (DC_B1) and the left block (DC_B3);

   a3) comparing the first differential value with the second differential value;

   a4) selecting the DC value (DC_B2) of the upper block if the first differential value is larger than the second differential value; and

   a5) selecting the DC value (DC_B3) of the left block if the first differential value is smaller than the second differential value.

31. The method as recited in Claim 30, wherein the first differential value and the second differential value are absolute values.

37. A block based video coding apparatus, comprising:

   selection means for selecting a DC value of one of a left block (B3) and a upper block (B2) based on a comparison of a first value and a second value, the first value being a difference between DC values of a left upper block (B1) and the left block (B3), the second value being a difference between DC values of the left upper block (B1) and the upper block (B2); and

   prediction means for predicting the selected DC value as a DC value of a target block (B), thereby generating a predictive DC value of the target block.

38. The apparatus as recited in claim 37, wherein said selection means includes:

means for obtaining a first differential value which is a difference between DC values of the left left upper block (DC_B1) and the upper block (DC_B2);

means for obtaining a second differential value which is a difference between DC values of the left upper block (DC_B1) and the left block (DC_B3);

means for comparing the first differential value with the second differential value;

means for selecting the DC value (DC_B2) of the upper block if the first differential value is larger than the second differential value; and

means for selecting the DC value (DC_B3) of the left block if the first differential value is smaller than the second differential value.

39. The apparatus as recited in Claim 37, wherein the first differential value and the second differential value are absolute values.

44. A block based video coding method for coding a target block based on a plurality of neighboring blocks wherein the neighboring blocks include a first block with a predetermined DC value, a second block with a predetermined DC value, and a third block with a predetermined DC value, the method comprising the steps of:

a) determining a first DC differential value based on the difference between the predetermined DC values of the first block and the third block;

b) determining a second DC differential value based on the difference between the predetermined DC values of the first block and the second block;

c) comparing the first DC differential value with the second DC differential value to obtain a predictive DC value;

d) transmitting the predictive DC value to a differential pulse code modulated coder; and

e) performing differential pulse code modulation coding on the predictive DC value.

45. The method as recited in claim 44, wherein the predictive DC value is:

a) the predetermined DC value of the second block if the first DC differential value is larger than the second DC differential value; and

b) the predetermined DC value of the third block if the first DC differential value is smaller than the second DC differential value.

46. The method as recited in claim 44, wherein the first DC differential value and the second DC differential value are absolute values.

47. The method as recited in claim 44, the method further comprising the steps of:

f) performing differential pulse code modulation coding on a predetermined DC value of target block;

g) generating video information based on the coded predictive DC value and the predetermined DC value of the target block; and

h) transmitting the video information to a decoder.

48. A block based video coding apparatus for coding a target block based on a plurality of neighboring blocks, the neighboring blocks including a first block with a predetermined DC value, a second block with a predetermined DC value, and a third block with a predetermined DC value, the apparatus comprising the steps of:

selector circuitry for selecting the predetermined DC value of one of the second block and the third block to obtain a predictive DC value for the target block; and

a differential pulse code modulation coder for receiving and coding the predictive DC value from the selector circuitry.

49. The apparatus as recited in claim 48, wherein the selector circuitry determines the predictive DC value based on the magnitude of one of a difference between the first block predetermined DC value and the third block predetermined DC value and a difference between the first block predetermined DC value and the second block predetermined DC value.

50. The apparatus as recited in claim 49, wherein said selector circuitry comprises:

memory circuitry for receiving and storing the predetermined DC values of the first block, the second block, and the third block;

a first subtractor in communication with the memory for determining a first value based on the difference between the first block predetermined DC value and the third block predetermined DC value;

a second subtractor in communication with the memory for determining a second value based on the difference between the first block predetermined DC value and the second block predetermined DC value;

a comparator in communication with the memory and the first and second subtractors for comparing the first value with the second value~~;~~.

51. The apparatus as recited in claim 50, further comprising an absolute value calculator in communication with the comparator and at least one of the first and second subtractors.

52. The apparatus as recited in claim 48, wherein the differential pulse code modulation coder receives a predetermined DC value for the target block and outputs video information based on coding of the predictive DC value and the predetermined DC value for the target block.

54. A block based video coding method, comprising the steps of:

a) calculating a vertical gradient of DC coefficients of a left upper block (B1) and a left block (B3), and the horizontal gradient of DC coefficients of the left upper block (B1) and a upper block (B2);

b) comparing the vertical gradient with the horizontal gradient; and

c) selecting one of the DC coefficients of the left block (B3) and the upper block (B2) as the predictive DC coefficient of a target block (B).

55. The method as recited in claim 54, wherein said step c) includes the steps of:

c1) selecting the DC coefficient (DC_B2) of the upper block as the predicted DC coefficient (DC_P) of the target block if the horizontal gradient is larger than the vertical gradient; and

c2) selecting the DC coefficient (DC_B3) of the left block as the predicted DC coefficient (DC_P) of the target block if the horizontal gradient is smaller than or equal to the vertical gradient.

56. The method as recited in claim 55, wherein the horizontal gradient and the vertical gradient are absolute values.

57. The method as recited in claim 54, further comprising the steps of:

d) performing a differential pulse code modulation (DPCM) coding on the predictive DC coefficient (DC_P) and the DC coefficient (DC_B) of the target block, thereby generating prediction error (DC_T); and

e) transmitting the prediction error to a decoder.

58. A block based video coding apparatus, comprising:

a DCT portion for receiving texture data, performing a discrete cosine transform (DCT) for the texture data, and outputting DCT coefficients including DC coefficients and AC coefficients;

a DC coefficient storage portion for temporarily storing the DC coefficients of the three adjacent blocks including the left upper block (B1), the upper block (B2) and the left block (B3) and outputting the DC coefficients; and

a predictive block selector for receiving the DC coefficients of said three adjacent blocks, selecting the predicted DC coefficients of the target block between the DC coefficient (DC_B2) of the upper block and the DC coefficient (DC_B3) of the left block, and outputting the predicted DC coefficient.

59. The apparatus as recited in Claim 58, further comprising:

a DPCM coder for performing a differential pulse code modulation (DPCM) on the predictive DC coefficient (DC_P) and the DC coefficient (DC_B) of the target block, thereby generating prediction error (DC_T) and transmitting the prediction error to a decoder.

60. The apparatus as recited in Claim 58, wherein said predictive block selector comprises:

a first substractor in communication with the DC coefficient storage portion for determining the vertical gradient between the DC coefficient of the left upper block (B1) and the DC coefficient of the left block (B3);

a second substractor in communication with DC coefficient storage portion for determining the horizontal gradient between the DC coefficient of the left upper block(B1) and the DC coefficient of the upper block (B2); and

a comparator in communication with the first and second subtractors for comparing the vertical gradient with the horizontal gradient.

61. The apparatus as recited in Claim 60, further comprising an absolute value calculator in communication with at least one of the first and the second subtractors.

(ix) EVIDENCE APPENDIX

CONTENTS

1. (Exhibit 1) International Organization for Standardization Organisation Internationale De Normalisation ISO/IEC JTC1.SC29/WG11, Coding of Moving Pictures and Associated Audio Information, by Sang-Hee Lee, Jae kyoon Kim (KAIST), Joo-hee Moon(Hyundai), July 1996, which demonstrates that the video coding scheme of the present invention was superior to other coding schemes known at that time.

2. (Exhibit 2) U.S. Patent Office patent database search results for the search terms "video" and "dct" and "dc coefficient" showing the earliest 30 of 580 patents identified, which shows that quite a bit of work has been done in this area in recent years.

3. (Exhibit 3) U.S. patent 4,953,020 (De With) which is the first patent to issue of the patents identified in the search of Exhibit 2, which illustrates that patents on use of DCT in video coding were first filed in the 1980's. De With was filed in the US in 1989.

STATEMENT OF WHERE EVIDENCE WAS ENTERED

The above Exhibits 1-3 were entered into the file before Appellants' Brief on Appeal was originally submitted. These Exhibits were submitted by the Applicants with an amendment under 37 C.F.R. 1.116 which was mailed to the Patent Office on July 5, 2005. An advisory action mailed by the Patent Office on July 26, 2005, responded to the amendment under 37 C.F.R. 1.116 and acknowledged the three references, although the Patent Office did not find Applicants' remarks at that time to be persuasive.

(x) RELATED PROCEEDINGS APPENDIX

Upon information and belief of undersigned counsel, appellants and the assignee of record are not aware that there are any pending appeals or interferences which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal. Consequently, this Appendix is empty.

EXHIBIT 1

INTERNATIONAL ORGANIZATION FOR STANDARDISATION
ORGANISATION INTERNATIONALE DE NORMALISATION
ISO/IEC JTC1/SC29/WG11
CODING OF MOVING PICTURES AND ASSOCIATED AUDIO INFORMATION

ISO/IEC JTC1/SC29/WG11
MPEG96/M1312
July 1996

Source: Korea Advanced Institute of Science and Technology(KAIST),
Hyundai Electronics Industries Co. Ltd.
Status: Information and Proposal
Title: Some Results and New Trials on Core Experiment T9/T10 - DC/AC Prediction
Author: Sang-hee Lee, Jae-kyoon Kim(KAIST), Joo-hee Moon(Hyundai)

1. Introduction

In this document, we report the experimental results of core experiment T9/T10, and some related trials - separation of DC/AC prediction and a new selective AC coefficient coding method.

Current participants of T9/T10 and their methods are listed below:

- Pel-domain prediction method proposed by Telenor
- DC/AC prediction method proposed by PSL
- DC prediction method proposed by Hyundai (Ours)
- DC prediction method proposed by AT&T

Among them, the pel-domain method is not considered in this document. The DC prediction method of Hyundai was proposed during the e-mail discussions after Tampere meeting, and described in section 3. The DC/AC prediction method of PSL has been updated since the meeting. Refer to the final description of T9/T10 to be distributed in this meeting. For the DC prediction method from AT&T, refer to the document MPEG96/1013.

The content of this document is as follows:
In section 2, performance of DC/AC prediction proposed by PSL is cross-checked, and we show it can be separated as a DC and an AC prediction method without any noticeable degradation of prediction gain. Based on this result, fair comparisons of DC prediction methods are carried out in section 3. In section 4, we propose a new AC coefficient coding technique which improves the prediction gain of the AC(and the DC/AC) prediction method. Section 5 summarizes all of results, and we draw conclusions in section 6.

Experimental conditions we used are as follows:

Test Sequences:	Class A (Akiyo, Mother & Daughter, Hall Monitor, Container Ship) Class B (Foreman, News, Silent Voice, Coastguard)
Resolution:	QCIF, CIF
QP	4, 12, 20
Frame No.	0

Apart from Telenor's method, all methods are lossless coding. Thus, generated bits and the percentage bit saving compared to VM, which is defined below, are used for judging the effectiveness of each scheme.

% bit saving =

$$\frac{\text{bits generated by VM 3.0 with DC prediction - bits generated by each method}}{\text{bits generated by VM 3.0 with DC prediction.}}$$

2. Separation of DC/AC Prediction - Performance Comparison of DC/AC Prediction of PSL with Separated DC and AC Prediction

DC/AC Prediction Method of PSL:

Between Tampere meeting and Chicago meeting, there have been many changes in the DC/AC prediction method of PSL. Major changes are as follows:

- 4 prediction modes with 2 bits overhead per macroblock
  - mode 0: DC prediction from the block above
  - mode 1: DC prediction from the block to the left
  - mode 2: DC/AC prediction from the block above
  - mode 3: DC/AC prediction from the block to the left
- Flexible number of coefficient prediction (VOP-basis)
- Mode decision using VLC decision
- Adaptive horizontal/vertical/zigzag scanning

To decide modes using VLC decision, we have to calculate the actual bits generated for the macroblock by each mode. It is very time-consuming, and requires high complexity. So, we used SAD formula also proposed by PSL in the last e-mail before VLC decision is proposed:

$$SAD_{\text{mode } i} = \sum_b \left[E_i(0,0) + 32 \sum_u |E_i(u,0)| + 32 \sum_v |E_i(0,v)| \right].$$

In the above formula, we used the same notations in MPEG96/0939 except for the changed meaning of each mode. We did not use H/V/Z scanning in the experiments.

Separation of the DC/AC Prediction method:

Whether DC/AC prediction method can be separated as a DC and an AC prediction or not is not a trivial issue. Separation of DC/AC prediction gives an additional flexibility to syntax, and we can concentrate on each one to improve the performance.

Based on the DC/AC prediction method of PSL, we can easily separate it as a DC and an AC prediction as follows:

DC prediction:

- 2 prediction modes with 1 bit overhead per macroblock
  - mode 0: DC prediction from the block above
  - mode 1: DC prediction from the block to the left

AC prediction:

- 3 prediction modes with 1 or 2 bits overhead per macroblock
  - mode 0: No prediction (1 bit overhead)
  - mode 1: AC prediction from the block above (2 bits overhead)
  - mode 2: AC prediction from the block to the left (2 bits overhead)

Mode decision rule:

SAD formula is applied separately, i.e.

$$SAD_{\text{mode } i} = \sum_b E_i(0,0), \qquad \text{for DC prediction,}$$

$$SAD_{\text{mode } i} = \sum_b \left[\sum_u |E_i(u,0)| + \sum_v |E_i(0,v)| \right], \quad \text{for AC prediction.}$$

Syntax chage:

In VOP header, 'intra_acpred_disale' bit which signals AC prediction should be inserted in a similar way to 'intra_dcpred_disable' in the current VM.

For the worst case, additional 1 bit per macroblock may be needed compared to the DC/AC prediction method. But, improved prediction accuracy due to the separation may be able to compensate the overhead.

Experimental Results:

Table 2-(a),(b) show the results. In the table, VMDC means VM 3.0 with intra prediction, and DCMB and ACPRED means the above separated DC and AC prediction method, respectively. There is not any noticeable performance difference between the two methods. Degradation of gain due to separation is only about 0.1%.

3. Performance Comparison of DC Prediction Methods

DC Prediction Method of Hyundai:

Our proposed DC prediction method is described below. It may be the best predictor for horizontal and vertical boundaries, and also suited quite well for oblique boundaries.

Algorithm Description:

In the figure shown below, D is the current block to be coded, and A, B and C represent the neighboring blocks already reconstructed.

A	B
C	D

Figure 1: Current block to be coded (D) and its neighboring blocks (A,B,C)

Let us denote the quantized DC coefficients of the block A, B, and C, as DC_A, DC_B, and DC_C, respectively. Then, the DC predictor for the current block, DCp, is decided as follows:

```
If( abs(DC_A-DC_C) < abs(DC_A-DC_B) )        DCp = DC_B
else                                         DCp = DC_C,          (1)
```

where abs(.) represents an absolute value operator.

In the special cases such as at the borders of the VOP, following rules are applied:

- If the DC value of the block A does not exist, it is set to 128.

And then,

- If the DC value of the block B does not exist, it is set to that of the block A.
- If the DC value of the block C does not exist, it is set to that of the block A.

And then, the above rule (1) is carried out.

Syntax Chage:

No syntax changes are required.

Complexity:

Very simple. It requires only two additions and one comparing operation per block.

Experimental Results:

We have compared the four DC prediction methods - VM's, AT&T's, DCMB method, and Hyundai's. Table 3-(a),(b) show the experimental results. Apart from the VM, the AT&T's method shows the worst performance. Performance of our method and the DCMB method is almost the same. But, our method do not require syntax changes and can be applied on block-basis. The complexity increment is negligible.

4. Performance Improvement of the AC Prediction Method - Selective Predictive Coding of an AC Coefficient

Introduction:

It is well known that the distribution of AC coefficients is usually centered around zero. That means, if we have to choose a prediction value for AC coefficients, it should be zero, resulting in no prediction. In spite of the remarkable prediction gain obtained from the AC prediction of T9/T10, it is somewhat dangerous to predict an AC coefficient by a nonzero neighboring coefficient. Even though neighboring 7 AC coefficients may be the best predictors in SAD sense for the corresponding 7 coefficients to be coded, there may be badly predicted coefficients among them.

We propose an effective AC coefficient prediction method called 'selective predictive coding of an AC coefficient'. The concept of the proposed technique is very simple: we use two predictor values for *each AC coefficient*; one is zero, and the other is the predictor obtained by the mode decision rule of the AC prediction method mentioned in section 2. Then, choose the nearest predictor value. We will incorporate our method into the AC prediction method, i.e. after mode decision is carried out by the AC prediction method, our method is applied only for those selected coefficients.

Figure 2-(a) illustrates the differential coding in AC prediction without our method, for the case that predictior P is equal to 5. Our method uses not only P but also 0 as a predictor, as shown in Figure 2-(b). It can reduce the absolute value of differential value remarkably if the coefficient to be coded is around 0. See the fifth column.

In the Figure, diffrentially coded values within the range B and C, cannot be uniquely decodable. Thus, we have to additonally encode an overhead bit. On the other hand, it is not needed for the range A and D.

coefficient to be coded (C)	prediction value (P)	differentially coded value (T)
...		
10		10-P = 5
9		9-P = 4
8		8-P = 3
7		7-P = 2
6		6-P = 1
5	P = 5	5-P = 0
4		4-P = -1
3		3-P = -2
2		2-P = -3
1		1-P = -4
0		0-P = -5
-1		-1-P = -6
-2		-2-P = -7
-3		-3-P = -8
-4		-4-P = -9
...		

(a) differential coding in the AC prediction method

coefficient to be coded (C)	prediction value (P or 0)	differentially coded value (T)		overhead bit	reduction of |T| compared to that in Figure 2-(a)
...		...			...
10		10-P = 5			0
9		9-P = 4	A	No	0
8		8-P = 3			0
7		7-P = 2			0
6		6-P = 1			0
5	P = 5	5-P = 0	B	1 bit	0
4		4-P = -1			0
3		3-P = -2			0
2		2-0 = 2			1
1		1-0 = 1			3
0	0	0-0 = 0	C	1 bit	5
-1		-1-0 = -1			5
-2		-2-0 = -2			5
-3		-3-0 = -3			5
-4		-4-0 = -4	D	No	5
...		...			...

(b) differential coding in the AC prediction method incorporating our selective prediction

Figure 2: Differential coding of an AC coefficient (Example)

Algorithm Description in Detail:

Our algorithm is carried out after doing mode decision of the AC prediction method. To incorporate the merit of our algorithm, the SAD formula should be slightliy modified, i.e., in the formula, the term representing absolute difference between the coefficient to be coded C and the neighboring predictor P is changed as min(|C|, |C-P|), where min(.) denotes a minimum operator. Following is a detailed description of our proposed method:

Let C and P be the coefficient to be coded and the predictor of C, respectively. For the sake of convenience, let us define following notations:

$$[n]_P = \begin{cases} n, & \text{if } P > 0 \\ -n, & \text{if } P < 0 \end{cases}$$

and

$$C' = [C]_P,$$
$$P_1 = [P/2+P]_P,$$
$$P_2 = [P/2]_P,$$
$$P_3 = [P/2-P]_P,$$
$$T' = [T]_P,$$

where '/' means interger division with truncation of the result toward zero.

Then, the prediction error T using C and P, is obtained as the following encoder algorithm, and C is restored from T and P by the decoder algorithm:

Encoder Algorithm Description:

If $P == 0$,

- $T = C$.

If $P \neq 0$,

- $T = \begin{cases} C - P, & \text{if } C' > P_2 \\ C, & \text{otherwise.} \end{cases}$
- $\begin{cases} \text{encode overhead bit NOPRED as '0'}, & \text{if } C' \leq P_1 \text{ and } C' > P_2 \\ \text{encode overhead bit NOPRED as '1'}, & \text{if } C' \leq P_2 \text{ and } C' > P_3 \\ \text{do not encode overhead bit NOPRED}, & \text{otherwise.} \end{cases}$

Decoder Algorithm Description:

If $P == 0$,

- $C = T$.

If $P \neq 0$,

- If $T' \leq P_2$ and $T' > P_3$, decode overhead bit NOPRED.
- $C = \begin{cases} T + P, & \text{if } T' > P_2 \text{ or NOPRED} == \text{'0'}. \\ T, & \text{if } T' \leq P_3 \text{ or NOPRED} == \text{'1'}. \end{cases}$

Syntax Change:

Block layer is changed as:

| INTRADC | TCOEFF | NOPREDS |

NOPREDS consists of a series of NOPRED bits. Its length is 0~7 bits.

Experimental Results:

Table 4-(a),(b), and Figure 3 show how much gain can be additionally achieved by using the proposed method. For all test sequences except the Mother & Daughter, we can obtain another 0.5~2.8% bit savings on the average, over the AC prediction method.

5. Summary of Overall Results

Table 1-(a),(b) summarize the results of DC and AC prediction methods considered in this document.

Methods		QP=4	QP=12	QP=20
DC prediction	AT&T's	0.6%	1.7%	2.7%
	DCMB (separated from PSL's)	1.1%	2.9%	4.5%
	Hyundai's	1.2%	3.0%	4.7%
AC prediction	ACPRED(separated from PSL's)	6.4%	9.1%	9.0%
	ACPRED + SELAC	8.4%	10.4%	9.9%
DC+AC prediction	Hyundai's DC+ ACPRED	7.6%	12.1%	13.7%
	Hyundai's DC+ ACPRED + SELAC	9.6%	13.4%	14.6%

(a) Results for QCIF sequences

Methods		QP=4	QP=12	QP=20
DC prediction	AT&T's	0.7%	1.7%	2.7%
	DCMB (separated from PSL's)	1.4%	3.6%	5.4%
	Hyundai's	1.4%	3.6%	5.4%
AC prediction	ACPRED(separated from PSL's)	7.3%	9.4%	8.4%
	ACPRED + SELAC	8.9%	10.5%	9.1%
DC+AC prediction	Hyundai's DC+ ACPRED	8.7%	13.0%	13.8%
	Hyundai's DC+ ACPRED + SELAC	10.3%	14.1%	14.5%

(a) Results for CIF sequences

Table 1: Summary of the results

6. Conclusions

In this document, we have carried out the experiments comparing the DC and AC prediction methods, and also propose a new AC coefficient coding method, which can improve the performance of the AC prediction method. Based on these results, we draw following conclusions:

- *The DC/AC prediction method can be easily separated as a DC and an AC prediction method.* The performance of the two is almost the same. It is expected that the separation gives more flexibility in syntax, and makes it possible for us to concentrate on each topic.

- *Proposed DC prediction method shows the best prediction performance.* Though the performance of macroblock-based DC prediction method is almost the same as ours, it is expected that the nature of our scheme - block-basis, no need of syntax change - will make it possible to be adopted as a solution of DC prediction.

- *By using the proposed AC coefficient coding method, about 1% additional bit savings can be achieved in the AC prediction method.*

QP	Scheme	Akiyo		M&D		Hall		Container	
4	VMDC	38107		35158		48442		53341	
	DC/AC of PSL	34991	8.2%	29768	15.3%	44222	8.7%	49368	7.4%
	DCMB+ACPRED	35011	8.1%	29792	15.3%	44308	8.5%	49373	7.4%
12	VMDC	15315		13688		20264		21297	
	DC/AC of PSL	13687	10.6%	10444	23.7%	17324	14.5%	18795	11.7%
	DCMB+ACPRED	13705	10.5%	10477	23.5%	17403	14.1%	18796	11.7%
20	VMDC	10177		9280		13418		13589	
	DC/AC of PSL	8981	11.8%	6976	24.8%	11332	15.5%	11706	13.9%
	DCMB+ACPRED	9024	11.3%	7013	24.4%	11401	15.0%	11690	14.0%
Average	DC/AC of PSL		10.2%		21.3%		12.9%		11.0%
	DCMB+ACPRED		10.0%		21.0%		12.6%		11.1%

QP	Scheme	Foreman		News		Silent		Coast		Average
4	VMDC	47089		56920		50001		47918		
	DC/AC of PSL	45391	3.6%	53369	6.2%	46766	6.5%	45637	4.8%	7.6%
	DCMB+ACPRED	45408	3.6%	53410	6.2%	46772	6.5%	45617	4.8%	7.5%
12	VMDC	18775		22465		16984		15464		
	DC/AC of PSL	17431	7.2%	20449	9.0%	15197	10.5%	14055	9.1%	12.0%
	DCMB+ACPRED	17417	7.2%	20495	8.8%	15195	10.5%	14028	9.3%	12.0%
20	VMDC	12304		14470		10648		8979		
	DC/AC of PSL	11100	9.8%	13059	9.8%	9403	11.7%	7897	12.1%	13.7%
	DCMB+ACPRED	11108	9.7%	13099	9.5%	9420	11.5%	7905	12.0%	13.4%
Average	DC/AC of PSL		6.8%		8.3%		9.6%		8.6%	11.1%
	DCMB+ACPRED		6.8%		8.1%		9.5%		8.7%	11.0%

Table 2-(a): VM with DC prediction vs. DC/AC prediction vs. Separated DC and AC predictions (QCIF)

QP	Scheme	Akiyo		M&D		Hall		Container	
4	VMDC	92301		88454		131378		169064	
	DC/AC of PSL	82221	10.9%	74760	15.5%	112348	14.5%	158108	6.5%
	DCMB+ACPRED	82353	10.8%	74858	15.4%	112448	14.4%	158140	6.5%
12	VMDC	40472		35508		57732		66194	
	DC/AC of PSL	35168	13.1%	27857	21.5%	46111	20.1%	59011	10.9%
	DCMB+ACPRED	35264	12.9%	27952	21.3%	46244	19.9%	59040	10.8%
20	VMDC	28565		25280		39915		42611	
	DC/AC of PSL	24847	13.0%	19513	22.8%	31833	20.2%	37520	11.9%
	DCMB+ACPRED	24930	12.7%	19598	22.5%	31949	20.0%	37595	11.8%
Average	DC/AC of PSL		12.3%		19.9%		18.3%		9.8%
	DCMB+ACPRED		12.1%		19.7%		18.1%		9.7%

QP	Scheme	Foreman		News		Silent		Coast		Average
4	VMDC	134843		148789		163493		186442		
	DC/AC of PSL	128709	4.5%	135812	8.7%	153391	6.2%	179826	3.5%	8.8%
	DCMB+ACPRED	128707	4.6%	135867	8.7%	153402	6.2%	179893	3.5%	8.7%
12	VMDC	50908		62643		53743		61927		
	DC/AC of PSL	46718	8.2%	55821	10.9%	46352	13.8%	57686	6.8%	13.2%
	DCMB+ACPRED	46761	8.1%	55860	10.8%	46380	13.7%	57783	6.7%	13.0%
20	VMDC	34284		41304		33408		35644		
	DC/AC of PSL	30815	10.1%	36761	11.0%	28547	14.6%	32596	8.6%	14.0%
	DCMB+ACPRED	30850	10.0%	36835	10.8%	28601	14.4%	32687	8.3%	13.8%
Average	DC/AC of PSL		7.6%		10.2%		11.5%		6.3%	12.0%
	DCMB+ACPRED		7.6%		10.1%		11.4%		6.2%	11.9%

Table 2-(b): VM with DC prediction vs. DC/AC prediction vs. Separated DC and AC predictions (CIF)

QP	Scheme	Akiyo		M&D		Hall		Container	
4	VMDC	38107		35158		48442		53341	
	AT&T	37901	0.5%	34766	1.1%	48325	0.2%	52901	0.8%
	DCMB	37408	1.8%	34380	2.2%	48089	0.7%	52916	0.8%
	Hyundai	37422	1.8%	34379	2.2%	48044	0.8%	52821	1.0%
12	VMDC	15315		13688		20264		21297	
	AT&T	15109	1.3%	13296	2.9%	20147	0.6%	20857	2.1%
	DCMB	14616	4.6%	12910	5.7%	19911	1.7%	20872	2.0%
	Hyundai	14630	4.5%	12909	5.7%	19866	2.0%	20777	2.4%
20	VMDC	10177		9280		13418		13589	
	AT&T	9971	2.0%	8888	4.2%	13301	0.9%	13149	3.2%
	DCMB	9478	6.9%	8502	8.4%	13065	2.6%	13164	3.1%
	Hyundai	9492	6.7%	8501	8.4%	13020	3.0%	13069	3.8%
Average	AT&T		1.3%		2.7%		0.6%		2.0%
	DCMB		4.4%		5.4%		1.7%		2.0%
	Hyundai		4.3%		5.4%		1.9%		2.4%

QP	Scheme	Foreman		News		Silent		Coast		Average
4	VMDC	47089		56920		50001		47918		
	AT&T	46838	0.5%	56526	0.7%	49859	0.3%	47482	0.9%	0.6%
	DCMB	46711	0.8%	56327	1.0%	49627	0.7%	47551	0.8%	1.1%
	Hyundai	46837	0.5%	56246	1.2%	49605	0.8%	47471	0.9%	1.2%
12	VMDC	18775		22465		16984		15464		
	AT&T	18524	1.3%	22071	1.8%	16842	0.8%	15028	2.8%	1.7%
	DCMB	18397	2.0%	21872	2.6%	16610	2.2%	15097	2.4%	2.9%
	Hyundai	18523	1.3%	21791	3.0%	16588	2.3%	15017	2.9%	3.0%
20	VMDC	12304		14470		10648		8979		
	AT&T	12053	2.0%	14076	2.7%	10506	1.3%	8543	4.9%	2.7%
	DCMB	11926	3.1%	13877	4.1%	10274	3.5%	8612	4.1%	4.5%
	Hyundai	12052	2.0%	13796	4.7%	10252	3.7%	8532	5.0%	4.7%
Average	AT&T		1.3%		1.7%		0.8%		2.9%	1.7%
	DCMB		2.0%		2.6%		2.2%		2.4%	2.8%
	Hyundai		1.3%		2.9%		2.3%		2.9%	2.9%

Table 3-(a): Comparison of DC prediction methods - VM vs. AT&T vs. DCMB vs. Hyundai (QCIF)

QP	Scheme	Akiyo		M&D		Hall		Container	
4	VMDC	92301		88454		131378		169064	
	AT&T	91473	0.9%	87875	0.7%	130707	0.5%	167870	0.7%
	DCMB	89959	2.5%	86312	2.4%	129433	1.5%	167757	0.8%
	Hyundai	89937	2.6%	86389	2.3%	129204	1.7%	167417	1.0%
12	VMDC	40472		35508		57732		66194	
	AT&T	39644	2.0%	34929	1.6%	57061	1.2%	65000	1.8%
	DCMB	38130	5.8%	33366	6.0%	55787	3.4%	64887	2.0%
	Hyundai	38108	5.8%	33443	5.8%	55558	3.8%	64547	2.5%
20	VMDC	28565		25280		39915		42611	
	AT&T	27737	2.9%	24701	2.3%	39244	1.7%	41417	2.8%
	DCMB	26223	8.2%	23138	8.5%	37970	4.9%	41304	3.1%
	Hyundai	26201	8.3%	23215	8.2%	37741	5.4%	40964	3.9%
Average	AT&T		1.9%		1.5%		1.1%		1.8%
	DCMB		5.5%		5.6%		3.2%		1.9%
	Hyundai		5.6%		5.4%		3.6%		2.4%

QP	Scheme	Foreman		News		Silent		Coast		Average
4	VMDC	134843		148789		163493		186442		
	AT&T	133838	0.7%	147683	0.7%	162745	0.5%	185073	0.7%	0.7%
	DCMB	133260	1.2%	146570	1.5%	161830	1.0%	185182	0.7%	1.4%
	Hyundai	133949	0.7%	146497	1.5%	161865	1.0%	185095	0.7%	1.4%
12	VMDC	50908		62643		53743		61927		
	AT&T	49903	2.0%	61537	1.8%	52995	1.4%	60558	2.2%	1.7%
	DCMB	49325	3.1%	60424	3.5%	52080	3.1%	60667	2.0%	3.6%
	Hyundai	50014	1.8%	60351	3.7%	52115	3.0%	60580	2.2%	3.6%
20	VMDC	34284		41304		33408		35644		
	AT&T	33279	2.9%	40198	2.7%	32660	2.2%	34275	3.8%	2.7%
	DCMB	32701	4.6%	39085	5.4%	31745	5.0%	34384	3.5%	5.4%
	Hyundai	33260	3.0%	39012	5.5%	31780	4.9%	34297	3.8%	5.4%
Average	AT&T		1.9%		1.7%		1.4%		2.3%	1.7%
	DCMB		3.0%		3.5%		3.0%		2.1%	3.5%
	Hyundai		1.8%		3.6%		3.0%		2.3%	3.5%

Table 3-(b): Comparison of DC prediction methods - VM vs. AT&T vs. DCMB vs. Hyundai (CIF)

QP	Scheme	Akiyo		M&D		Hall		Container	
4	VMDC	38107		35158		48442		53341	
	VMDC+ACPRED	35710	6.3%	30570	13.0%	44661	7.8%	49798	6.6%
	VMDC+ACPRED+SELAC	34913	8.4%	30341	13.7%	43449	10.3%	48372	9.3%
12	VMDC	15315		13688		20264		21297	
	VMDC+ACPRED	14404	5.9%	11255	17.8%	17756	12.4%	19194	9.9%
	VMDC+ACPRED+SELAC	14010	8.5%	11367	17.0%	17518	13.6%	18730	12.1%
20	VMDC	10177		9280		13418		13589	
	VMDC+ACPRED	9723	4.5%	7791	16.0%	11754	12.4%	12115	10.8%
	VMDC+ACPRED+SELAC	9574	5.9%	7902	14.8%	11601	13.5%	11891	12.5%
Average	VMDC+ACPRED		5.6%		15.6%		10.9%		9.1%
	VMDC+ACPRED+SELAC		7.6%		15.2%		12.5%		11.3%

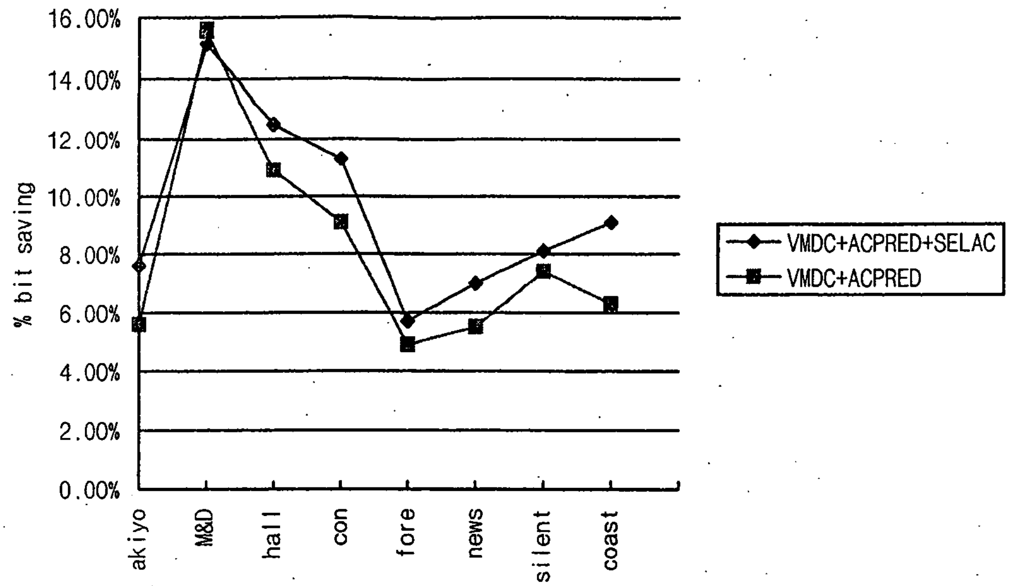
QP	Scheme	Foreman		News		Silent		Coast		Average
4	VMDC	47089		56920		50001		47918		
	VMDC+ACPRED	45786	2.8%	54003	5.1%	47146	5.7%	45984	4.0%	6.4%
	VMDC+ACPRED+SELAC	45059	4.3%	53055	6.8%	46240	7.5%	44547	7.0%	8.4%
12	VMDC	18775		22465		16984		15464		
	VMDC+ACPRED	17795	5.2%	21088	6.1%	15569	8.3%	14395	6.9%	9.1%
	VMDC+ACPRED+SELAC	17709	5.7%	20788	7.5%	15527	8.6%	13879	10.2%	10.4%
20	VMDC	12304		14470		10648		8979		
	VMDC+ACPRED	11486	6.6%	13692	5.4%	9794	8.0%	8272	7.9%	9.0%
	VMDC+ACPRED+SELAC	11445	7.0%	13504	6.7%	9760	8.3%	8072	10.1%	9.9%
Average	VMDC+ACPRED		4.9%		5.5%		7.4%		6.3%	8.2%
	VMDC+ACPRED+SELAC		5.7%		7.0%		8.1%		9.1%	9.6%

Table 4-(a): Performance of proposed AC coding method - VM vs. AC prediction vs. AC prediction with proposed method(QCIF)

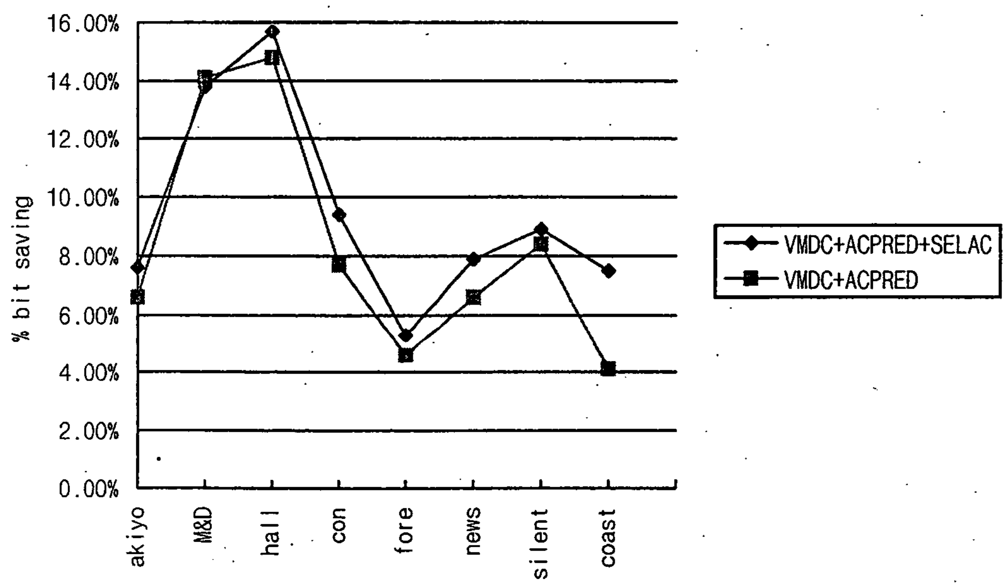
QP	Scheme	Akiyo		M&D		Hall		Container	
4	VMDC	92301		88454		131378		169064	
	VMDC+ACPRED	84695	8.2%	77000	12.9%	114393	12.9%	159447	5.7%
	VMDC+ACPRED+SELAC	83248	9.8%	76431	13.6%	112244	14.6%	155795	7.8%
12	VMDC	40472		35508		57732		66194	
	VMDC+ACPRED	37606	7.1%	30094	15.2%	48189	16.5%	60347	8.8%
	VMDC+ACPRED+SELAC	37293	7.9%	30319	14.6%	47788	17.2%	59190	10.6%
20	VMDC	28565		25280		39915		42611	
	VMDC+ACPRED	27272	4.5%	21740	14.0%	33894	15.1%	38902	8.7%
	VMDC+ACPRED+SELAC	27094	5.1%	21970	13.1%	33811	15.3%	38409	9.9%
Average	VMDC+ACPRED		6.6%		14.1%		14.8%		7.7%
	VMDC+ACPRED+SELAC		7.6%		13.8%		15.7%		9.4%

QP	Scheme	Foreman		News		Silent		Coast		Average
4	VMDC	134843		148789		163493		186442		
	VMDC+ACPRED	130290	3.4%	138086	7.2%	155065	5.2%	181153	2.8%	7.3%
	VMDC+ACPRED+SELAC	128778	4.5%	135752	8.8%	153216	6.3%	175090	6.1%	8.9%
12	VMDC	50908		62643		53743		61927		
	VMDC+ACPRED	48344	5.0%	58097	7.3%	48043	10.6%	59043	4.7%	9.4%
	VMDC+ACPRED+SELAC	47963	5.8%	57296	8.5%	47758	11.1%	56814	8.3%	10.5%
20	VMDC	34284		41304		33408		35644		
	VMDC+ACPRED	32433	5.4%	39054	5.4%	30264	9.4%	33947	4.8%	8.4%
	VMDC+ACPRED+SELAC	32322	5.7%	38673	6.4%	30323	9.2%	32778	8.0%	9.1%
Average	VMDC+ACPRED		4.6%		6.6%		8.4%		4.1%	8.4%
	VMDC+ACPRED+SELAC		5.3%		7.9%		8.9%		7.5%	9.5%

Table 4-(b): Performance of proposed AC coding method - VM vs. AC prediction vs. AC prediction with proposed method(CIF)



(a) QCIF(Average for QP=4,12,20)



(b) CIF (Average for QP=4,12,20)

Figure 3: Performance of proposed AC coding method

USPTO PATENT FULL-TEXT AND IMAGE DATABASE

Home | Quick | Advanced | Pat Num | Help

Prev. List | Bottom | View Cart

EXHIBIT 2

Searching 1976 to present...

Results of Search in 1976 to present db for:
((video AND dct) AND "dc coefficient"): 580 patents.
*Hits **551** through **580** out of **580***

Prev. 50 Hits

Jump To

Refine Search: video and dct and "dc coefficient"

	PAT. NO.		Title
551	5,301,242	T	Apparatus and method for motion video encoding employing an adaptive quantizer
552	5,301,032	T	Digital image compression and decompression method and apparatus using variable-length coding
553	5,293,434	T	Technique for use in a transform coder for imparting robustness to compressed image data through use of global block transformations
554	5,287,178	T	Reset control network for a video signal encoder
555	5,282,031	T	Fixed bit rate compression encoding method
556	5,270,832	T	System for compression and decompression of video data using discrete cosine transform and coding techniques
557	5,267,037	T	Interframe-coded output data amount control system
558	5,262,854	T	Lower resolution HDTV receivers
559	5,253,078	T	System for compression and decompression of video data using discrete cosine transform and coding techniques
560	5,251,033	T	D.C. responsive equalization for television transmission channel irregularities
561	5,251,028	T	Apparatus for reducing quantization artifacts in an interframe hybrid coding system with motion compensation
562	5,245,428	T	Television system for transmitting picture signals in a digital format
563	5,243,428	T	Method and apparatus for concealing errors in a digital television
564	5,233,348	T	Variable length code word decoder for use in digital communication systems
565	5,231,486	T	Data separation processing in a dual channel digital high definition television system
566	5,231,384	T	Apparatus for splitting video signal between two channels
567	5,227,878	T	Adaptive coding and decoding of frames and fields of video

568 5,196,946 T System for compression and decompression of video data using discrete cosine transform and coding techniques
569 5,193,010 T Digital video signal recording and reproducing apparatus having an error concealment control function
570 5,191,548 T System for compression and decompression of video data using discrete cosine transform and coding techniques
571 5,179,442 T Method and apparatus for digitally processing a high definition television augmentation signal
572 5,168,356 T Apparatus for segmenting encoded video signal for transmission
573 5,162,908 T Coding method for increasing data compression efficiency in transmitting or storing picture signals
574 5,148,272 T Apparatus for recombining prioritized video data
575 5,144,425 T Apparatus for hierarchically dividing video signals
576 5,122,875 T An HDTV compression system
577 5,111,292 T Priority selection apparatus as for a video signal processor
578 5,006,931 T Highly efficient coding apparatus
579 5,001,559 T Transform coding using coefficient prediction techniques
580 4,953,020 T Television transmission system with differential encoding of transform coefficients

---

Prev. List | Top | View Cart

Home | Quick | Advanced | Pat Num | Help